

Calorimetry

Calorimetry is the measurement of energy changes in chemical reactions.

To carry out calorimetry, we must assume:

1. No heat is transferred to or from the surroundings (a closed system).
2. No heat is absorbed or released from the equipment used.
3. The density & heat capacity of any aqueous solution is equal to that of pure water ($D = 1.00 \text{ g/mL}$ and $c = 4.18 \text{ J/g}\cdot^\circ\text{C}$)

A calorimeter is an instrument designed for these experiments. A simple calorimeter allows a reaction to be carried out in an aqueous solution without the loss of heat (Figure 1). A bomb calorimeter (Figure 2) allows a reaction to be carried out in a separate chamber and the heat produced is measured by the temperature change in the water jacket.

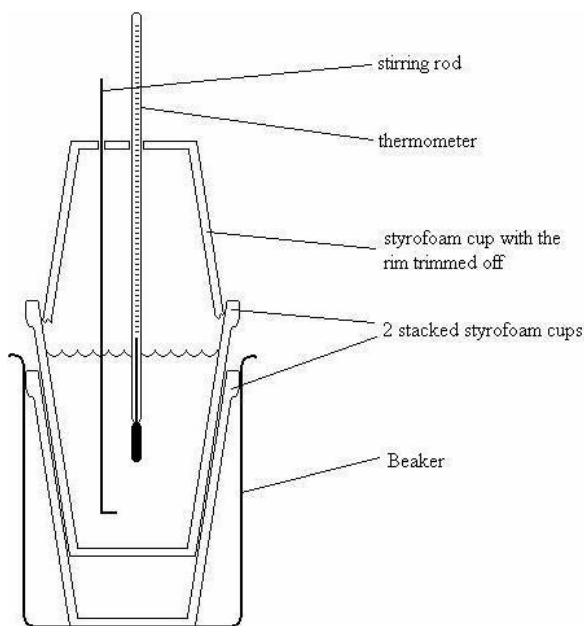


Figure 1: A Simple Calorimeter

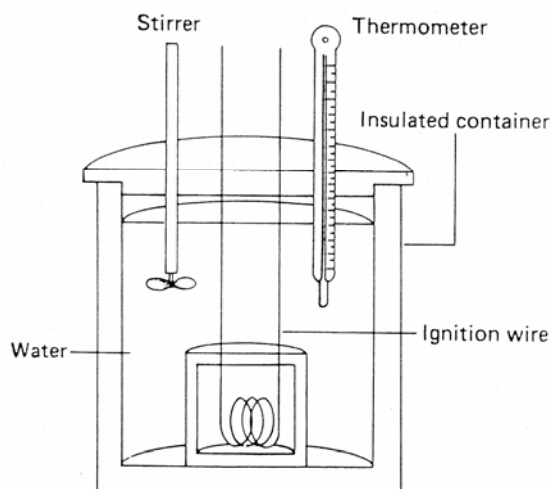


Figure 2: A Bomb Calorimeter

To investigate an energy change, we use the law of conservation of energy that tells us the change in energy of a chemical system is the same as the change in energy of the surroundings:

$$\Delta H_{\text{sys}} = \pm |q_{\text{surroundings}}|$$

If $q_{\text{surroundings}}$ is positive then the change is exothermic ($-\Delta H$).

If $q_{\text{surroundings}}$ is negative then the change is endothermic ($+\Delta H$).

Calculating Heat of Reaction using Calorimetry

As energy is added or removed from a substance, the temperature of a substance changes.

- amount of energy (q in Joules)
- amount of material (m or mass in grams)
- type of material (c , the specific heat capacity in J/g·°C)
- temperature change ($\Delta T = T_f - T_i$)

$$q = mc \Delta T$$

In calorimetry, the energy change is usually calculated by the change in temperature of a known quantity of water inside the calorimeter.

Therefore the molar enthalpy (heat of reaction) can be found:

$$\Delta H = \frac{q_{rxn}}{n}$$

e.g.1 If 5.2 g of sodium hydroxide undergoes a reaction that results in the temperature of 250 mL of water to increase from 21.0°C to 28.0°C. Calculate the heat of reaction (in kJ per mole) of sodium hydroxide.

e.g.2 What be the final temperature in a calorimeter containing 250 mL of water at 22.4°C if 10.0 g of ammonium nitrate is completely dissolved?

